100.01 Purpose

The Washington State Department of Transportation (WSDOT) has developed the *Design Manual* to reflect policy, outline a uniformity of methods and procedures, and communicate vital information to its employees and others who develop projects on state highways. When properly used, it will facilitate the development of a highway system consistent with the needs of the traveling public. WSDOT designers are required to comply with the *Design Manual*. The Federal Highway Administration (FHWA) has agreed to approve designs that follow guidance in the *Design Manual*; adherence to the guidance presented, therefore, is not optional for state highway projects.

The information, guidance, and references contained herein are not intended as a substitute for sound engineering judgement. It is recognized that some situations encountered are beyond the scope of this presentation, as the *Design Manual* is not a comprehensive textbook on highway engineering. Nor does it attempt to cover all the possible scenarios that Washington's highways present.

For design questions beyond the scope of the *Design Manual*, contact the Headquarters (HQ) Design Office.

100.02 Presentation and Revisions

The *Design Manual* is available in an up-to-date format on the Internet. It can be accessed through the WSDOT home page, the Design Policy and Standards home page, or the Engineering Publications Online Library home page. Opening the manual on the Internet can take considerable time. However, it provides the ability to conduct a word search of the whole manual. Opening an individual chapter is faster, but a word search is limited to that chapter.

The *Design Manual* is also available on "Engineering Publications CD Library" (a CD-ROM). The CD is up-to-date as of the date of production. Hard-copy editions are available on a department cost-recovery basis (free to WSDOT employees).

The *Design Manual* is continually revised to reflect changing processes, procedures, regulations, and organizations. Feedback from users is encouraged to improve the manual for everyone. For example, material that is unclear to one user will most likely be unclear to others.

Engineering Publications maintains a list of people interested in receiving e-mail notification when a revision is being distributed. Comments may be submitted by any method that is convenient for the user. There is a Comment Form in the manual, telephone numbers for the authors are available through the Design Policy and Standards home page, and the manual has its own e-mail address.

A Contents section is provided at the front of the *Design Manual* that lists all chapters, their major headings, and the last revision dates on the pages. There is also a list of all figures, with their page numbers and dates. The dates are provided to aid in determining whether a manual or page is up-to-date. By comparing a printed book or CD file to the manual on the Internet, the date in the footer of the Contents pages will indicate whether the latest revision is in place.

The *Design Manual* is divided into general divisions that contain specialized chapters and an index at the back of the manual.

Each chapter provides a list of the references that are the basis for the information in the chapter, including laws, administrative codes, manuals, and other publications. Each chapter provides definitions for the specialized vocabulary used in the chapter, particularly when a word or phrase has more than one dictionary meaning.

The index lists all significant chapter subheadings, other items selected by the chapters' authors and contributors, and many items suggested by users. Suggestions are helpful because one user's search might help other users later.

100.03 *Design Manual* Applications

The *Design Manual* guidance is provided to encourage uniform application of design details under normal conditions throughout the state. It also guides designers through the project development process used by WSDOT. The *Design Manual* is used by the department: to interpret current design principles, including American Association of State Highway and Transportation Officials (AASHTO) policy and federal and state laws; to develop projects to meet driver expectations; and to balance the benefits and costs of highway construction projects. This manual is designed to allow for flexibility in design for specific and unusual situations. For unusual circumstances, the *Design Manual* provides mechanisms for documenting the reasons for the choices made.

The *Design Manual* supplements engineering analysis and judgment; it is not intended as an engineering textbook. The manual is developed for use on state highways and it may not be suitable for projects on county roads or city streets.

100.04 How the *Design Manual* is to be Used

The WSDOT *Design Manual* is intended to be used for design of department-owned facilities, especially the transportation facilities associated with state highways as designated by the Revised Code of Washington (RCW) 47.17.

For state highway routes, all projects must be designed using the geometric control criteria (see Chapter 325 and Division Four) in the *Design Manual*. If WSDOT guidance is not used on a project, appropriate documentation and approvals are required. (See Chapters 325 and 330).

When WSDOT designs facilities to be turned over to local jurisdictions, those facilities are to be designed using appropriate local geometric design criteria.

When local jurisdictions design any element of state highway facilities, this manual must be used. Local jurisdictions are free to adopt this manual for their local criteria or to develop their own specialized guidance for facilities not on state highway routes.

100.05 The Project Development Process

The *Design Manual* addresses the project development process from programming through the Design Approval. The *Design Manual* is a comprehensive guide to the design of transportation projects; however, the full extent of project development is beyond the scope of the *Design Manual*. The following paragraphs provide a brief summary to assist the designer in understanding the relationship between planning, programming, and design at WSDOT.

Project development is a multi-disciplinary effort that develops the needs identified in the *Washington State Highway System Plan* (HSP) and subsequent planning studies in sufficient detail to produce a set of contract documents. This process bridges the gap from project concept to project construction. The project definition documents provide the framework for further development of the project scope, schedule and estimate, and record key decisions made early in the project development process. Final project design decisions are archived in the Design Decision Package (DDP). The contract documents provide sufficient detail to enable contractors to construct the project.

A global understanding of the overall project development process is important in order to eliminate corrective modifications or rework in the later stages of project implementation. Project modifications and rework are not only costly, they also impact delivery commitments made to the Legislature and the public. Integrating planning, program management, and project delivery are vital to efficient and successful delivery of transportation projects. These projects must have information and processes that flow seamlessly between the planning and the implementation phases of a project. A level of analysis guideline (a series of questions addressed to the design engineer) has been developed to address common

areas where a lack of information has caused significant changes late in the design process. (See the web site: http://wwwi.wsdot.wa.gov/ppsc/pgmmgt/scoping/LevelAnalysis.pdf)

The HSP is the modal element of the *Washington Transportation Plan* (WTP) that addresses the state's highway system. The HSP, managed by the WSDOT HQ Systems Analysis and Program Development Office, includes a comprehensive assessment of existing and projected 20-year needs on the Washington State highway system. Freight, mobility, safety, bicycle, and pedestrian issues are among the 20-year needs. The HSP also lists potential solutions addressing these needs.

The HSP identifies four major programs that are used to manage the state-owned transportation system. These are:

- Maintenance Program (M)
- Operations Program (Q)
- Preservation Program (P)
- Improvement Program (I)

HQ Systems Analysis and Program Development staff begins programming the Preservation and Improvement programs for the highway construction program by sending out to the WSDOT regions the list of needs for each action strategy identified in the department's *Highway System Plan*. Each region takes the lists of needs and performs an engineering analysis on each need, in order, based on the programming instructions. They must develop a project alternative(s) consistent with the department's design matrices, estimate the cost to accomplish that work, and determine the resulting benefits (what performance change can be achieved).

Based on the resulting benefit to cost ratio (b/c), the projects are prioritized based on the highest to lowest ratio for each system plan strategy. Following this step, HQ Program Development develops different budget scenarios for the available investment dollars for the next 2- to 6-year period.

WSDOT has a responsibility to develop a 6-year highway construction program based on projected revenues (RCW 47.05 - Priority programming for highway development). This effort begins by using the Project Summary process to develop an accurate scope, accurate schedule, and accurate budget. Included in the Project Summary are:

- A project definition
- An Environmental Review Summary/ Environmental Classification Summary
- A cost estimate
- A Design Decision Summary, when required for the project type

In addition, WSDOT develops a 10-year Capital Improvement and Preservation Program (CIPP) that includes a listing, cost estimate, and brief description of every capital improvement project in progress or to be in progress over the next 10-years. The CIPP is adopted by the Transportation Commission and submitted to the Governor and, ultimately, by the Governor to the Legislature. The CIPP is updated each biennium.

Program development staff in the regions work closely with region project development staff to identify projects where preliminary engineering funds are available to develop the contract documents. As these funds become available, the Project Development Engineers are notified, and a Project Engineer is identified to lead the project development process. At this point, the Project Engineer assembles a design team and goes to work on development of the project documents.

Design teams are encouraged to use the Managing Project Delivery (MPD) process to map out the direction and the expectations for the project. The MPD process focuses on planning the work and executing the plan. (See Chapter 140.)

The planning study recommendations are used to develop the Project Definition. Following the project definition and required hearings or public involvement, a set of Plans, Specifications and Estimates (PS&E) is completed and used to advertise the project for construction.

The key to maintaining consistency from the planning stage into project construction is to rely on good communication between the planning offices, program management, design engineers, support functions, and the construction office. In general, communication should be thought of as constant and bi-directional. There are always many opportunities throughout the life of a project for these communications to take place.

100.06 How the *Design Manual* is Organized

The *Design Manual* is divided into a series of divisions that address a portion of the project development and design process. The divisions are composed of chapters that address the general topic identified in the division in detail and are, in some cases, specific to a particular discipline.

Division One presents general background on the processes that precede project design. These include planning, managing project delivery, project development, and programming.

- Chapter 100–Manual Description: Informs the designer about content and resources within the *Design Manual*.
- Chapter 120–Planning: Informs the designer about resources that can provide critical information relating to the corridor in which the project resides, such as Corridor Studies and Route Development Plans.
- Chapter 140–Managing Project Delivery: Provides the designer with the resources to build an effective project development work plan.
- Chapter 141–Project Development Roles and Responsibilities for Projects with Structures: Presents the project development process used by WSDOT to determine the roles and responsibilities for projects with structures during the project development phase of a project.
- Chapter 150–Project Development: Describes the Project Development sequence from the *Washington Transportation Plan* (WTP) through the contract document, with emphasis on the Project Summary and Change Management process.

Division Two provides the designer with information about the public involvement and hearings process, the environmental documentation process, and the permit process.

- Chapter 210–Public Involvement and Hearings: Informs the designer about developing a public involvement plan that meets the specific needs of the project; the ingredients of an effective public involvement plan; and methods for public involvement.
- Chapter 220–Project Environmental Documentation: Provides the designer with elementary background on the environmental documentation process and the many requirements.
- Chapter 240–Permits and Approvals: Explains permits that may be required for highway and bridge projects.

Division Three provides designers with information on value engineering, design matrices, design documentation, and approvals.

- Chapter 315–Value Engineering: A systematic multi-disciplinary process study early in the project design to provide recommendations to improve scope, functional design, constructability, environmental impacts, or project cost. Value Engineering studies are required by federal law for high-cost, complex projects.
- Chapter 325–Design Matrices: Includes five figures that provide consistency across projects according to funding type and highway system. Each design matrix sets forth the level of development for a given type of need, which would be automatically approved by the department and FHWA. Deviating from the matrix requires approval. The Design Matrix figures assist the designer to apply the appropriate design level for the majority of improvement and preservation projects.
- Chapter 330–Design Documentation, Approval, and Process Review: Covers building the Project File (PF), and the Design Documentation Package (DDP). The Project File and Design Documentation Package record the recommendations and decisions that lead to a project by preserving the documents from planning, scoping, programming, and design phases, including permits, approvals, contracts, utility relocation, right of way, advertisement, award, and construction for a project.
- Chapter 340–Minor Operational Enhancement Projects (Q Program): Provides design matrices for low-cost, quick-fix projects that improve the operation of a state highway facility.

Division Four includes project design criteria for basic design, modified design, and full design that are part of the design matrices in Chapter 325.

- Chapter 410–Basic Design Level: Contains the required basic safety work and minor preservation and safety work included in the preservation of pavement structures and pavement service life, while maintaining safe operation of the highway.
- Chapter 430–Modified Design Level: Provides the design guidance that is unique to the Modified Design Level of preserving and improving existing roadway geometrics, safety and operational elements.
- Chapter 440–Full Design Level: Provides guidance for the highest level of highway design, to improve roadway geometrics, safety and operational elements. Full Design Level is used on new and reconstructed highways.

Division Five presents guidance for investigating soils, rock, and surfacing materials, estimating tables, and guidance and criteria for the use of geosynthetics.

- Chapter 510–Investigation of Soils, Rock, and Surfacing Materials: Describes the requirements for qualifying a materials source, geotechnical investigations, and the documentation to be included in the Project File.
- Chapter 520–Design of Pavement Structures: Provides estimating tables for the design of pavement structures.
- Chapter 530–Geosynthetics: Introduces the types and applications of geosynthetic drainage, earthwork, erosion control, and soil reinforcement materials.

Division Six covers an introduction to highway capacity; geometric plan elements; horizontal alignment; lane configurations and pavement transitions; geometric profile elements; vertical alignment; geometric cross sections; and sight distance.

- Chapter 610–Highway Capacity: Provides the designer with a basic and limited introduction to highway capacity.
- Chapter 620–Geometric Plan Elements: Provides guidance on the design of horizontal alignment, lane configuration, and pavement transitions.
- Chapter 630–Geometric Profile Elements: Furnishes guidance for the design of vertical alignment.
- Chapter 640–Geometric Cross Section: Introduces the designer to roadway width, superelevation, and slope design.
- Chapter 641–Turning Roadways: Provides guidance for widening curves to make the operating conditions comparable to those on tangent sections.
- Chapter 642–Superelevation: Provides guidance on superelevating curves and ramps so that design speeds can be maintained.
- Chapter 650–Sight Distance: Addresses passing, stopping, and decision sight distance design elements.

Division Seven addresses design considerations for the area outside of the roadway, and includes clear zone, roadside hazards, safety mitigation, traffic barriers, and impact attenuator systems.

- Chapter 700–Roadside Safety: Presents clear zone design, roadside hazards to consider for mitigation, and some roadside safety features.
- Chapter 710–Traffic Barriers: Provides guidance for the design of traffic barriers based on the design levels identified in the Design Matrices.
- Chapter 720–Impact Attenuator Systems: Introduces the designer to permanent and work zone impact attenuator systems.

Division Eight introduces the designer to traffic safety elements such as work zone traffic control, signing, delineation, illumination, traffic control signals, and Intelligent Transportation Systems (ITS).

- Chapter 810–Work Zone Traffic Control: Addresses the planning, design, and preparation of highway improvement and preservation project plans for modification of traffic patterns during construction.

- Chapter 820–Signing: Presents the use of signing to regulate, warn, and guide motorists.
- Chapter 830–Delineation: Presents the use of pavement markings to designate safe traffic movement.
- Chapter 840–Illumination: Provides guidance on the use of illumination on state highway construction projects.
- Chapter 850–Traffic Control Signals: Offers the designer guidance in the use of power-operated traffic control devices that warn or direct traffic.
- Chapter 860–Intelligent Transportation Systems (ITS): Provides guidance on applying computer and communication technology to optimize the safety and efficiency of the highway system by providing motorists timely traffic condition information.

Division Nine addresses the design considerations of at-grade intersections, roundabouts, road approaches, railroad grade crossings, and traffic interchanges.

- Chapter 910–Intersections At-Grade: Provides guidance for designing intersections at-grade, including at-grade ramp terminals.
- Chapter 915–Roundabouts: Instructs the designer on the design of roundabouts.
- Chapter 920–Road Approaches: Informs the designer about the application and design of road approaches on state highways in unincorporated areas, and in incorporated areas where limited access rights have not been acquired.
- Chapter 930–Railroad Grade Crossings: Addresses the requirements associated with highways crossing railroads.
- Chapter 940–Traffic Interchanges: Provides guidance in the design of interchanges on Interstate highways, freeways, and other multilane divided routes.

Division Ten offers guidance on auxiliary lanes such as climbing lanes and passing lanes; bicycle facilities; pedestrian design considerations; safety rest areas and traveler services; weigh stations; high occupancy vehicle lanes; and transit benefit facilities.

- Chapter 1010–Auxiliary Lanes: Provides guidance on auxiliary facilities such as climbing lanes, passing lanes, slow vehicle turnouts, shoulder driving for slow vehicles, emergency escape ramps, and chain-up areas.
- Chapter 1020–Bicycle Facilities: Serves as a guide for selecting and designing useful and cost-effective bicycle facilities.
- Chapter 1025–Pedestrian Design Considerations: Supplies guidance for designing facilities that encourage safe and efficient pedestrian access.
- Chapter 1030–Safety Rest Areas and Traveler Services: Provides typical layouts for Safety Rest Areas.
- Chapter 1040–Weigh Sites: Provides guidance for the design of permanent, portable, and shoulder-sited weigh sites.
- Chapter 1050–High Occupancy Vehicle Facilities: Presents guidance on evaluating and designing high occupancy vehicle (HOV) facilities.
- Chapter 1060–Transit Benefit Facilities: Provides operational guidance and information for designing transit benefit facilities such as park-and-ride lots; transfer/transit centers; and bus stops and pullouts.

Division Eleven provides guidance for the design of structures for highway projects, including site data for structures, bridges, retaining walls, and noise walls.

- Chapter 1110–Site Data for Structures: Describes the information required by the WSDOT HQ Bridge and Structures Office to provide structural design services.
- Chapter 1120–Bridges: Provides basic design considerations for the development of a preliminary bridge plan and guidelines on basic bridge geometric features.

- Chapter 1130–Retaining Walls and Steep Reinforced Slopes: Provides design principles, requirements, and guidelines for retaining walls and steep reinforced slopes.
- Chapter 1140–Noise Barriers: Addresses the factors that are considered when designing a noise barrier.

Division Twelve addresses the issue of hydraulics, and serves as a guide to highway designers to identify and consider hydraulic-related factors that may impact the design.

- Chapter 1210–Hydraulic Design: Addresses hydraulic considerations for highway projects involving flood plains, stream crossing, channel changes, and ground water.

Division Thirteen provides guidance on the portion of state highways between the traveled way and the right of way boundary.

- Chapter 1300–Roadside Development: Presents guidance on managing the roadside environment, including the area between the traveled way and the right of way boundary, unpaved median strips, and auxiliary facilities such as rest areas, wetlands, and storm water treatment facilities.
- Chapter 1320–Vegetation: Provides a discussion of the use of vegetation in the roadside environment and directs the designer to the Landscape Architect.
- Chapter 1330–Irrigation: Presents design considerations for irrigation on highway projects.
- Chapter 1350–Soil Bioengineering: Offers a discussion of bioengineering and design considerations for the use of bioengineering techniques on highway projects.

Division Fourteen provides guidance on right of way considerations; access point decision reports; limited and managed access; surveying and mapping; monumentation; and fencing.

- Chapter 1410–Right of Way Considerations: Explains the right of way and easement acquisition process.
- Chapter 1420–Access Control: Introduces the WSDOT Access Control program.
- Chapter 1425–Access Point Decision Report: Describes the process for access point revisions on state highways and explains the steps leading up to an Access Point Decision Report.
- Chapter 1430–Limited Access: Provides clarification on limited, full, and modified access control.
- Chapter 1435–Managed Access: Explains the classes of managed access and the permitting process, and provides design considerations.
- Chapter 1440–Surveying and Mapping: Introduces the procedures within WSDOT for project surveying.
- Chapter 1450 Monumentation: Introduces monumentation requirements and procedures.
- Chapter 1460 Fencing: Introduces fencing, the purpose of fencing, the types of fencing, and fencing design criteria.